How To Fill Out a g-2 BoE

Brian Drendel

11/20/12

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Introduction

The g-2 Basis of Estimate (BoE) template is an Excel spreadsheet that is intended to streamline the BoE writing process. The spreadsheet was designed to make the process more efficient, provide a consistent implementation and prevent errors. Resource ID codes, contingencies, dependencies and the risk management are all built into the BoE template. This will not only streamline creation of the individual BoEs, but also make more efficient the transfer of BoE information to other documents that will be needed for the project including the Resource Loaded Schedule (RLS) and Risk Registries. But what exactly is a BoE?

A BOE form is a tool that we use to document labor and purchasing costs for a portion of the project. We start with the Work Breakout Structure (WBS), which is a tree-like structure that divides the total cost of a project into smaller portions. Level 1 is the entire project cost. Level 2 is under that and consists of three components: Rings, Detectors and Accelerators. Each Level 2 breaks down further into Level 3 and then Level 4, and possibly further until the costing is broken into manageable sized pieces. The last level of the WBS structure is called the terminal block. A BoE document will provide the costing at every terminal block in the WBS structure.

The cost structure of the WBS is broken down in time into the following four categories.

- **Conceptual Design**: This is the work that is done between Critical Decision-0 (CD-0) and CD-1, and leads to the Conceptual Design Report. Conceptual design is in progress as of the writing of this document and will be costed separate from the individual BoEs.
- **Preliminary Design**: Work that occurs between Critical Decision 1 (CD-1) and CD-2. Preliminary Design costing is covered in Step 5 of this document.
- **Final Design**: Work that occurs between CD-2 and CD-3, leading a Technical Design Report (TDR). Final Design costing is covered in Step 6 of this document.
- **Implementation**: Work that occurs between CD-3 and CD-4, leading to construction of the project. Implementation costing is covered in step 7 of this document.

At the time that this document was being written, we were in the Conceptual Design stage. The costing for this stage will be handled separately from the other three categories listed above and not included in your general BoE documents. Your BoE documents will have individual sections for Preliminary Design, Final Design and Implementation.

The costing for each of the above three sections are further divided into activities. Activities are the items that go into the schedule. Inside of your BoE, you will provide a labor hours and/or M&S cost estimate for each activity.

Steps are the individual items that you need to complete each activity. They are not on the schedule, but can be used to track the progress on the activity. Steps are not individually documented inside of the BoE; however, it is encouraged that they be listed in the notes field.

Each activity has either a labor or M&S cost associated with it, or both. We have a Resource ID table that lists employee types as well as M&S types. For each activity, we select item(s) from the Resource ID table that are needed to complete the project. An example of a labor Resource ID code is FNAD._ENGNRING_PHYST, which is a Fermilab Accelerator Division Engineering Physicist. An example of a M&S Resource ID is FN_MS_STND which is the M&S standard code. The BoE template has a built in spreadsheet of valid Resource ID codes.

Each row of our BoE table with have either:

- Activity + Labor Resource ID + Hours
- Activity + M&S Resource ID + K$

In addition, for each activity the BoE will address dependencies, contingency and alternate funding. Each activity will have a cell to document which other activities are predecessors. Contingency is based on a defined set of estimate types that are hard coded into the BoE template. Alternate funding can be selected from a pull-down menu if appropriate.

The BoE also leaves room to document any opportunities or risks. Opportunities are items that could potentially save the project money as compared to the base plan. Risks are items that would potentially add cost. Each risk or opportunity is divided into one of four categories (Schedule, cost, ES&H or technical) and then assigned levels of probability, impact and severity based on risk management tables built into the BoE template.

Construction of a BoE is a thirteen step process, which we will outline below. The BoE template, an example filled out BoE form and this document all reside in GM2-Doc-320 (http://gm2-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=320).

Step 1: Obtain a copy of the BoE template

1. Go to GM2 document via the following link - http://gm2-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=320.
    a. Login using the G2Muon account (ask for password).
2. Click on “Excel Template” to download the Excel BoE template.
3. Save the file using the following naming convention which contains both the WBS number and WBS name.
    a. BoE – 476.##.##.## - WBS Name –v{date}.xlsx

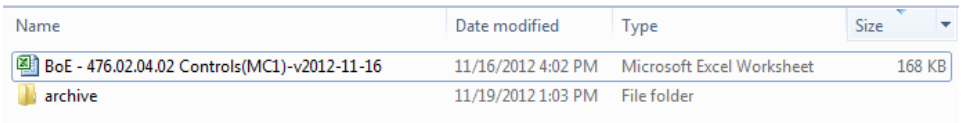


Figure 1: Copy the BoE template to your area.

Step 2: Create a g-2 Documents Database file.

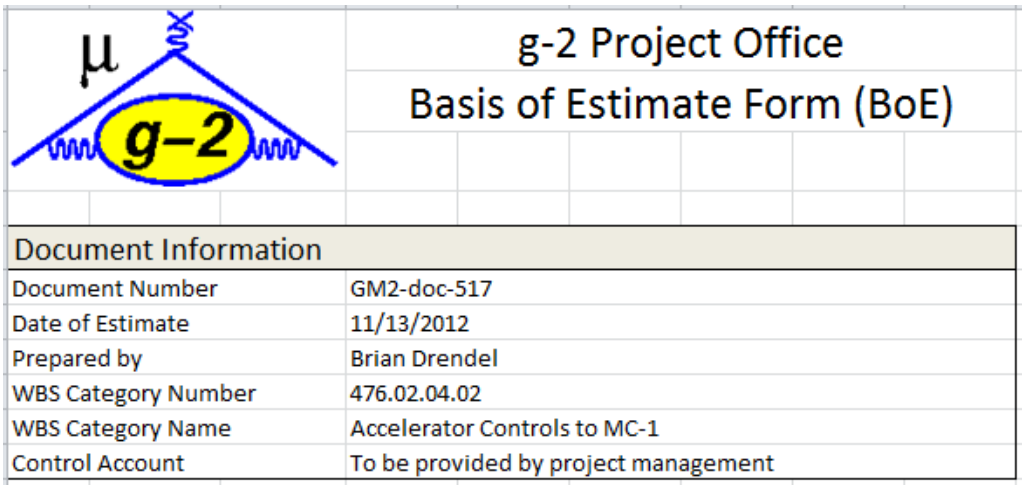
1. Go to http://gm2-docdb.fnal.gov/
2. Click on the "Private" access option and login using the G2Moun account (ask for password).
3. At the bottom of the page, click NEW to create a new document.
4. The document name should be made suing the following naming convention
    a. BoE – 476.##.##.## - WBS Name
5. Include an abstract that provides a basic description of what the Boe
6. Include the keyword BoE.
7. Upload your Excel BoE file and any supporting documentation to this document.
8. An example g-2 Documents database document is shown in Figure 2.

Figure 2: Create a g-2 Documents Database document.

Step 3: Fill out the BoE cover sheet

1. Navigate to the CoverSheet workbook inside of the template.

2. Fill out the cover sheet *document information table* as shown in Figure 3. Make sure to fill out the following information.
    a. Document Database number
    b. Date of last edit
    c. Prepared by
    d. WBS number
    e. WBS name



Document Information	
Document Number	GM2-doc-517
Date of Estimate	11/13/2012
Prepared by	Brian Drendel
WBS Category Number	476.02.04.02
WBS Category Name	Accelerator Controls to MC-1
Control Account	To be provided by project management

Figure 3: Basic cover sheet information is used to automatically populate other portions of the BoE document.

3. Fill out the cover sheet supporting documents table as shown in Figure 4. Be sure to include
    a. Cite your sources.
    b. Provide hyperlinks to each document.

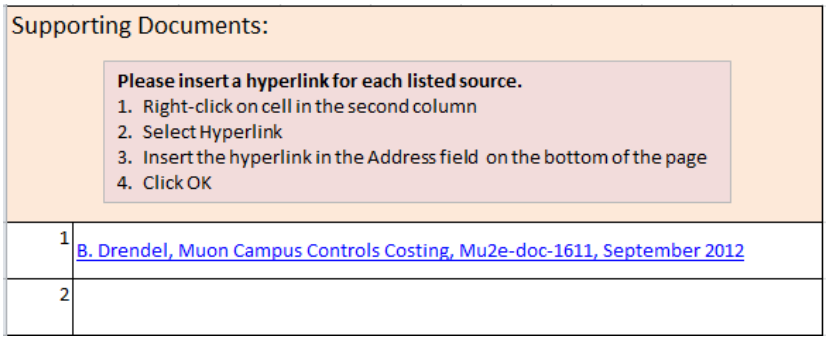


Figure 4: Each supporting document should be listed in this table, along with a hyperlink to the document.

4. Fill out the description table with a short paragraph describing the purpose of the BoE as shown in figure 5.

Dictionary Description
Design, repurposing, fabrication and installation of devices that provide an interface between the Accelerator Controls System and devices in the upstream M4 line, g-2 beam lines and MC-1 experimental building.

Figure 5: Description of BoE.

Step 4: Determine Your Resource IDs.

Resource ID's are where we charge work and will be needed in Step 5 of this procedure. At this point you will identify which Resouce ID's will be necessary to complete your BoE.

1. Navigate to the ResourceLabor workbook.

2. Search the table for the Labor Resource ID's that you will be charging work to. It should be noted that only a few of the over 500 available Resource IDs are shown here.

Resource IDs (labor)	
Task Code	
FN_S_PRJ_CTRL_ENTRY	Project Controls Entry
FN_S_PRJ_CTRL_MID	Project Controls Mid
FN_S_PRJ_CTRL_SR	Project Controls Sr
FNAD_AC_EXP_PHYST	Accelerator Physicist Experimental
FNAD_AC_EXP_RA	Accelerator Experimental Research Associate
FNAD_AC_OPERATOR	Accelerator Operator
FNAD_AC_SYSTM_SPCLST	Accelerator Systems Specialist
FNAD_AC_THY_PHYST	Accelerator Physicist Theory
FNAD_AC_THY_RA	Accelerator Theory Research Associate
FNAD_ACCOUNTANT	Accountant
FNAD_ADMIN_SPPRT	Administrative Support
FNAD_APDEV_SYSTMAYST	Applications Development & Systems Analyst
FNAD_ASIC_DESIGN_EN	ASIC Design Engineer

3. Navigate to the ResourceM&S workbook.

4. Search the table for the M&S Resource ID's that you will be charging work to.

Resource IDs (M&S)				
M&S Task Code	Prefix	Suffix	Description	Overheads
FN_MS_EXMP	FN	MS_EXMP	M&S Exempt	1
FN_MS_INKIND	FN	MS_INKIND	M&S Pass-Thru	0
FN_MS_PASS	FN	MS_PASS	M&S Standard	1.015
FN_MS_STND	FN	MS_STND	M&S Travel	1.23
FN_MS_TRVL	FN	MS_TRVL	M&S Inkind	1.23

Step 5: Preliminary Design

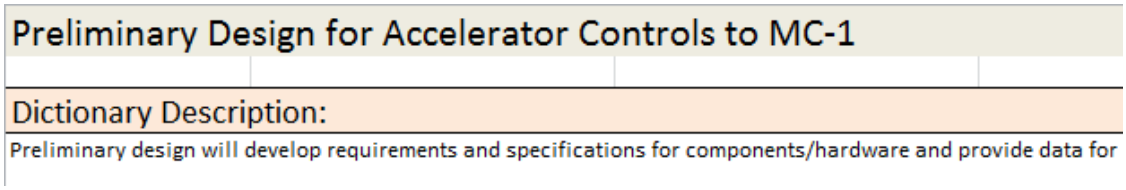
The Preliminary Design costing covers all costing associated with work that occurs between CD-1 and CD-2. There are four sub-steps which will be outlined below.

a) Preliminary Design Description.
b) Preliminary Design Activities.
c) Preliminary Design Labor Estimates.
d) Preliminary Design M&S Estimates.

To begin the Preliminary Design Costing process, navigate to the Preliminary Design workbook and follow the steps outlined below.

Step 5a: Preliminary Design Description

1. The title of the workbook is populated automatically based on data from the cover sheet. Enter a description of what the Preliminary Design portion of this BoE is intended to accomplish.

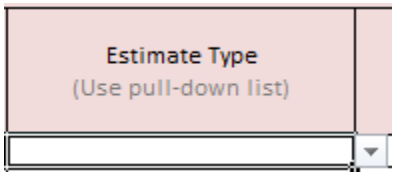


Step 5b: Preliminary Design Activities

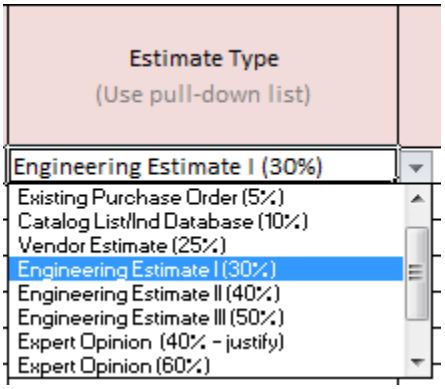
1. The activity numbers in the leftmost column are hard coded. For each activity that you define in the BoE enter a short Activity Name and a longer Activity Description.

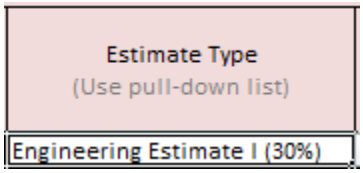
Activities and Dependences:		
Activity #	Activity Name	Activity Description
100	Engineering Oversight	Coordination and oversight of activities associated with designing the controls connection to MC-1.
110	Controls Design and Planning	Design and Plan work for connecting MC-1 to the controls network.
120	Electronics Prep	Preparing electronics for controls connection to MC-1
130	Network Drawings	Network drawings and documentation

2. For each Activity, we will select an Estimate Type from a pull-down menu. The Estimate Type is a measure of how confident we can cost that activity and determines the contingency. In the Estimate Type column, click on a cell and you will notice a little down arrow. Click on the down arrow.

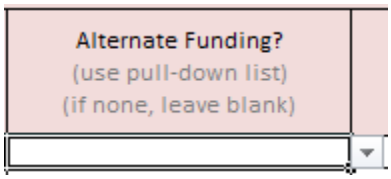


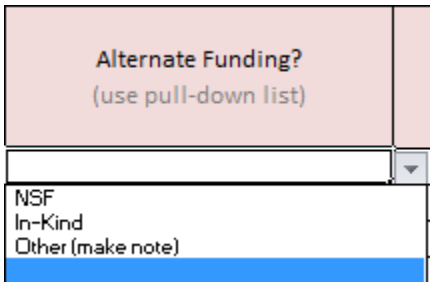
3. A pull-down menu appears, giving you choices. Select the estimate type that best matches your level of confidence for this activity.



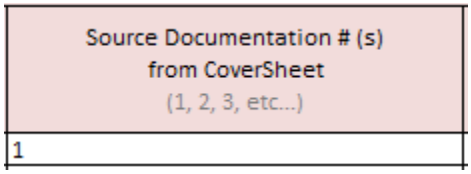


4. In some cases, the activity may be paid via alternative funding. If this is the case, use the pull-down menu to select the source of alternative funding. If alternative funding is not used for this activity, just leave the cell blank.

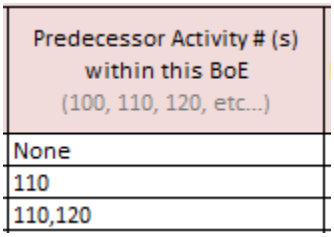




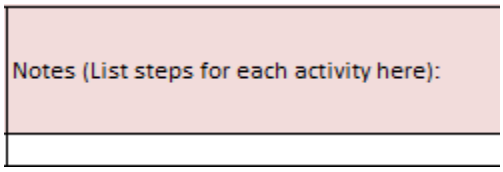
5. For each activity, we can specify source documentation from the cover sheet what we filled out in Step 3.3. Type the number(s) of any source documentation listed on the cover sheet that apply to this Activity.



6. For each activity listed in this workbook, specify if any activities are predecessors. A predecessor is an activity that must be completed before the existing activity can start. An activity can have more than one predecessor.



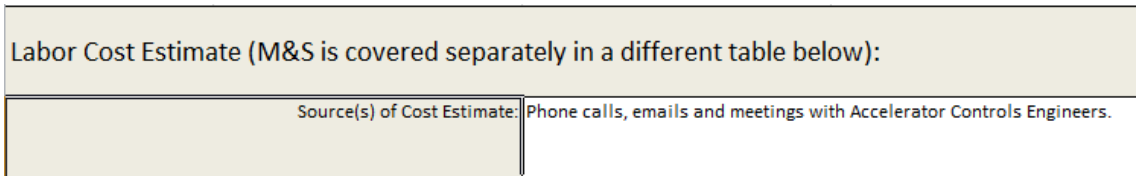
7. In the notes field, put any additional information specific to the activity. List the individual steps used to track this activity here.



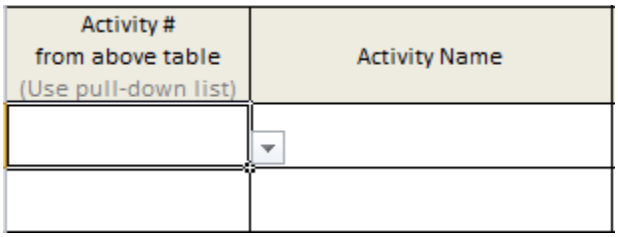
Step 5c: Preliminary Design Labor Cost

Next we will complete the Preliminary Design Labor Cost estimate table.

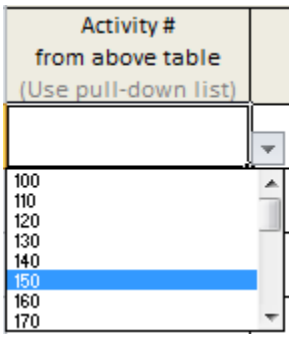
1. Fill in the source(s) of cost estimate. This should be an indication of where the labor estimates were derived.



2. In Step 5b we defined activities. We will now select each of those activities for which has a labor cost associated with it. Click on a cell in the Activities column.



3. From the pull-down menu, select an activity number. These are the numbers in the leftmost column from Step 5b.2.



4. If you select an activity that does not have an Activity Name you will get an error as shown here. If this happens, either select another activity or go back to Step 5b.2 and enter an Activity Name.

Activity # from above table (Use pull-down list)	Activity Name
110	Enter an Activity Name in the Activity Table

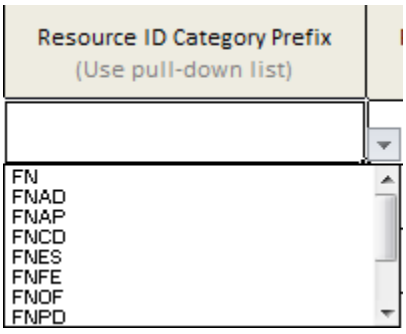
5. If you select an activity that has a valid name, that name will be displayed in green text.

Activity # from above table (Use pull-down list)	Activity Name
100	Engineering Oversight

6. We will next select a labor Resource ID. **Refer to Step 4.1 to determine which labor type to select for the given activity.** If more than one Resource ID is attached to an Activity, then we will fill out one row for each individual Resource ID that we wish to charge. There are over 500 labor Resource IDs to choose from using pull-down menus. In order to speed up the selection process, the search has been broken into two parts. The first half of the search has you select the first digits of the Resource ID, which we call the Resource ID Prefix. The second half of the search has you select the remainder of the Resource ID string, which we call the Resource ID Suffix. Once both prefix and suffix are selected, the spreadsheet verifies that a valid Resource ID has been selected.

Resource ID Category Prefix (Use pull-down list)	Resource ID Category Suffix (Use pull-down list)	Resource ID Validity Check (Populated Automatically)

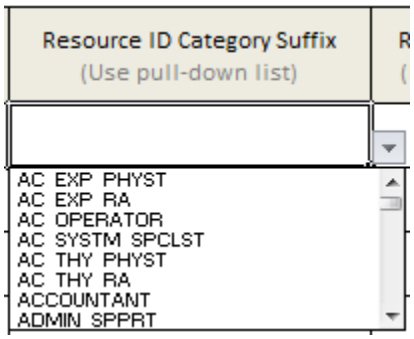
7. Click the Resource ID Category Prefix cell, to select a value from the pull-down menu.



8. Note at this point, the Resource ID is not yet valid.

Resource ID Category Prefix (Use pull-down list)	Resource ID Category Suffix (Use pull-down list)	Resource ID Validity Check (Populated Automatically)
FNAD		Resource ID is not valid

9. Next, click the Resource ID Category Suffix cell, to select from a value in the pull-down menu.



10. The spreadsheet verifies the valid Resource ID by displaying it in green text.

Resource ID Category Prefix (Use pull-down list)	Resource ID Category Suffix (Use pull-down list)	Resource ID Validity Check (Populated Automatically)
FNAD	ENGNRING_PHYST	FNAD_ENGNRING_PHYST

11. Next, you will fill in how many hours will be charged to the selected activity and Resource ID. Type an integer number without any units.

Base Estimate (hours) {Enter without any units}

12. Conversion of hours to dollars is done automatically based on Resource ID selected. For Preliminary Design we assume FY'13 pay rates.

Base Estimate (hours) {Enter without any units}	BoE Pay Rate (FY'13 $/hr) (From lookup table)	BoE Base Estimate (K$) (Auto Populated)
100	$170.00	$17.00K

13. Next, the spreadsheet applies contingency to the base estimate. A valid estimate type for the selected activity must be in place. If the activity does not have an estimate type, an error will be generated. If this is the case, go back to Step 5b.3 and select an Estimate Type for the selected activity.

Estimate Type (Populated from Activities Table)	Contingency (%) (Auto Populated)	Base + Contingency (hours) {Calculated}	Base + Contingency BoE(K$) {Calculated}
No Estimate Type in Activity Table			

14. When a valid estimate type is in place, the estimate type field will be populated and contingency applied.

Estimate Type (Populated from Activities Table)	Contingency (%) (Auto Populated)	Base + Contingency (hours) {Calculated}	Base + Contingency BoE(K$) {Calculated}
Engineering Estimate I (30%)	30%	130.00	$22.10K

15. If there is any additional information concerning the selected activity, a notes field is available to enter this information.

Notes

Step 5d: Preliminary Design M&S Cost

Next we will complete the Preliminary Design M&S Cost estimate table.

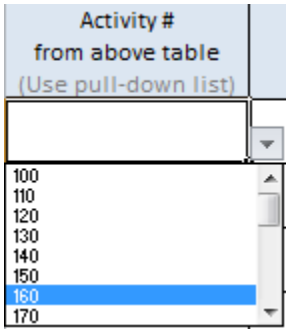
1. Fill in the source(s) of cost estimate. This should be an indication of where the labor estimates were derived.

M&S Cost Estimate (Labor is covered separately in a different table above):	
Source(s) of Cost Estimate:	Phone calls, emails and meetings with Accelerator Controls Engineers.

2. In Step 5b we defined activities. We will now select each of those activities for which have an M&S cost associated with it. Click on a cell in the Activities column.

Activity # from above table (Use pull-down list)	Activity Name	Item Purchased

3. From the pull-down menu, select an activity number. These are the numbers in the leftmost column from Step 5b.2.



4. If you select an activity that does not have an Activity Name you will get an error as shown here. If this happens, either select another activity or go back to Step 5b.2 and enter an Activity Name.

Activity # from above table (Use pull-down list)	Activity Name	Item Purchased
110	Enter an Activity Name in the Activity Table	

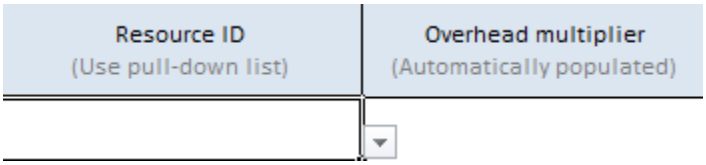
5. If you select an activity that has a valid name, that name will be displayed in green text.

Activity # from above table (Use pull-down list)	Activity Name	Item Purchased
100	Terminate Fiber Optic Cables	

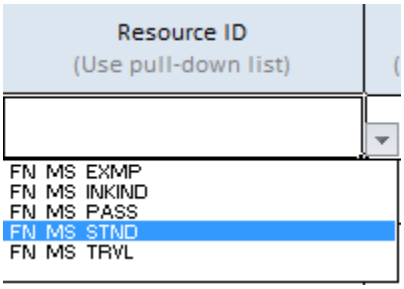
6. Enter a brief Items Purchased description.

Activity # from above table (Use pull-down list)	Activity Name	Item Purchased
100	Terminate Fiber Optic Cables	Contract Electricians

7. We will next select a M&S Resource ID. **Refer to Step 4.3 to determine which M&S type to select for the given activity.** If more than one Resource ID is attached to an Activity, then we will fill out one row for each individual Resource ID that we wish to charge. There are only a handful of M&S Resource IDs, so the selection can be completed with a single pull-down menu.



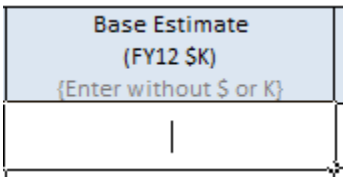
8. Click on the Resource ID cell, to select from a value in the pull-down menu.



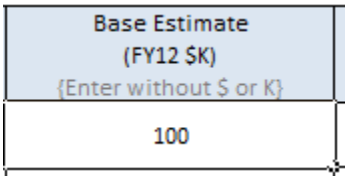
9. The Resource ID is populated, along with the appropriate overhead multiplier.

Resource ID (Use pull-down list)	Overhead multiplier (Automatically populated)
FN_MS_STND	1.23

10. Next enter your base estimate cost.



11. Type in your number of thousand dollars. **NOTE: Do not enter units or the "$" sign, just type the number**.



12. When you click enter, the spreadsheet will display the units and "$" sign.

Base Estimate (FY12 $K) {Enter without $ or K}
$100.00K

13. Next, the spreadsheet applies contingency to the base estimate. A valid estimate type for the selected activity must be in place. If the activity does not have an estimate type, an error will be generated. If this is the case, go back to Step 5b.3 and select an Estimate Type for the selected activity.

Estimate Type (Populated from Activities Table)	Contingency (%) (Auto Populated)	Base + Contingency + Overhead (FY12 $K) {Calculated}
No Estimate Type in Activity Table		

14. When a valid estimate type is in place, the estimate type field will be populated and contingency applied.

Estimate Type (Populated from Activities Table)	Contingency (%) (Auto Populated)	Base + Contingency + Overhead (FY12 $K) {Calculated}
Engineering Estimate I (30%)	30%	$159.90K

15. If there is any additional information concerning the selected activity, a notes field is available to enter this information.

Notes

Step 6: Final Design

The Final Design costing covers all costing associated with work that occurs between CD-2 and CD-3. At the completion of the final design, a Technical Design Report (TDR) will be completed. There are four sub-steps which will be outlined below.

a) Final Design Description.
b) Final Design Activities.
c) Final Design Labor Estimates.
d) Final Design M&S Estimates.

To begin the Final Design Costing process,

1. Navigate to the Final Design workbook.

2. Repeat all of the steps completed in Step 5 in the Final Design workbook.

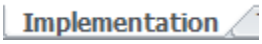
Step 7: Implementation

The Implementation costing covers all costing associated with work that occurs between CD-3 and CD-4. At the completion of Implementation, construction begins. There are four sub-steps which will be outlined below.

a) Implementation Description.
b) Implementation Activities.
c) Implementation Labor Estimates.
d) Implementation M&S Estimates.

To begin the Final Design Costing process,

1. Navigate to the Final Design workbook.



2. Repeat all of the steps completed in Step 5 in the Final Design workbook.

Step 8: Check Costing Summary

A costing summery worksheet exists that summarized the grand totals of all labor and M&S.

1. Navigate to the Totals workbook

2. Verify that the expected costing information exists.

	Base Labor (Hours)	Base Labor ($K)	Base + Contingecy Labor (Hours)	Base + Contingecy Labor ($K)	Base M&S (K$)	Base + Contingecy M&S ($K)	Base Labor & M&S ($K)	Base + Contingency Labor & M&S ($K)
Preliminary Design	100	$13.76K	130	$17.89K	$0.00K	$0.00K	$13.76K	$17.89K
Final Design	100	$14.02K	130	$18.23K	$0.00K	$0.00K	$14.02K	$18.23K
Implementation	60	$10.60K	78	$13.78K	$39.24K	$62.74K	$49.84K	$76.52K
Totals	260	$38.38K	338	$49.89K	$39.24K	$62.74K	$77.62K	$112.64K

3. If costing is missing, then verify Steps 5, 6 and 7 were completed above.

Step 9: Additional Information

The Additional Information workbook is used to document additional material associated with the BoE. Examples include more detailed information on the activities and steps in each BoEs, engineer spreadsheets. Since text formatting is not as powerful in Excel as it is in Word and other applications, it is acceptable to have the content of this section in external documents located in the same Documents Database document. If that is the case, the source should be cited in this location, along with a brief description of what is contained in that source.

1. Navigate to the Additional Information worksheet and enter your information.

2. Enter data into the table or reference an external data source.

Additional Background Information:	
New fiber optic cable will be pulled from the MAC Room to the MC1 service building. Single-mode fiber is needed for Ethernet and FIRUS and multimode fiber is neede to MC-1. The fiber bundle will share a common path with the fiber bundles headed toward AP30 and Mu2e from the cross gallery to the manhole by Booster West Tower manhole inside a common inner duct, and then separate into the new communication ducts to the Mu2e and MC1 service buildings. The fiber pulls will provide ample cc approaching 100MB/sec during production data taking which can be handled easily with the proposed infrastructure. A detailed M&S costing breakdown is listed below.	
	M & S Base Plan (72 count single mode/24 count multi-mode)
Singlemode Fiber from MAC room to MC-1 (1,500 feet) $1.50/foot for standard single mode $2.70/foot for 72 fiber single mode/24 fiber multi-mode $21.50/foot for rad hardened)	$4.05K
Inner duct (1,500 feet at $1.00/foot)	$1.5K
AP30 Fiber Termination Shelf	$0.275K

Step 10: Known Dependences

This section allows the user to define any dependences on this BoE to other BoEs in the WBS structure.

1. Navigate to the Known Dependences worksheet

2. Enter the dependencies in either the predecessors (must finish before this BoE) or successors (require this BoE to be complete before starting).

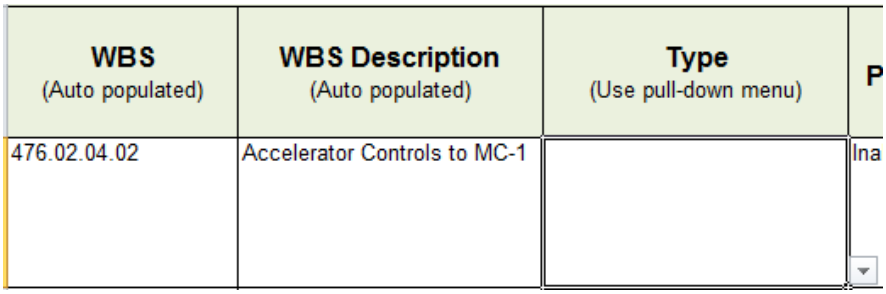
Known Dependencies from other WBS Entries:
Predecessors: None
Successors: Most be completed before any commissioning of devices in the M4 line, g-2 line or MC-1 service building.

Step 11: Opportunities and Risks

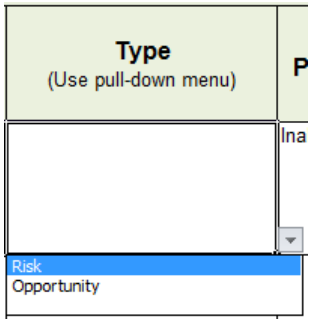
Opportunities are potential cost saving measures and risks are potential cost increasing events. This section allows the user to define opportunities and risks for this BoE, which can be used to build a Risk Registry.

1. Navigate to the Opportunities and Risks worksheet

2. The WBS number and description fields are automatically populated based on data in the cover sheet. Click on the Type cell, then the down arrow to generate the pull-down menu.



3. Select from type choices of Risk or Opportunity.



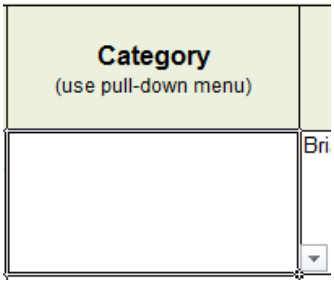
4. In this example, we will select Risk.

WBS (Auto populated)	WBS Description (Auto populated)	Type (Use pull-down menu)
476.02.04.02	Accelerator Controls to MC-1	Risk

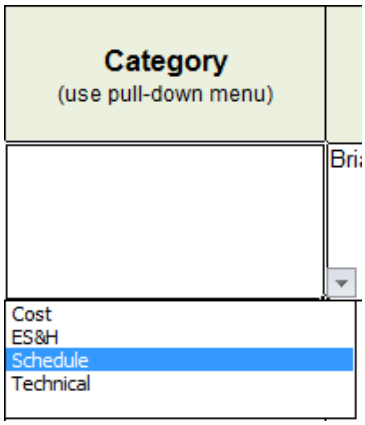
5. Fill in the Potential Problem, Cause and Consequence box. The Potential Problem box is intended to be a very short description of the problem, the Cause box is what element causes the problem and the consequence box is a more detailed description of the problem.

Potential Problem/Opportunity (short description)	**Cause**	**Consequence** (longer description of Column D item)
Inability to complete cable pull	The communications ducts are too full for additional cable pulls.	Insufficient room to pull the innerduct that houses the fiber optic cable bundle.

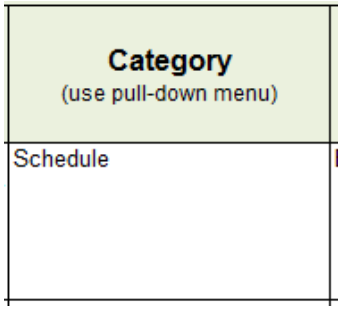
6. Click in the cell for Category to enable the pull-down menu.



7. Select the appropriate Category from the pull-down menu.



8. In this example, we select schedule.



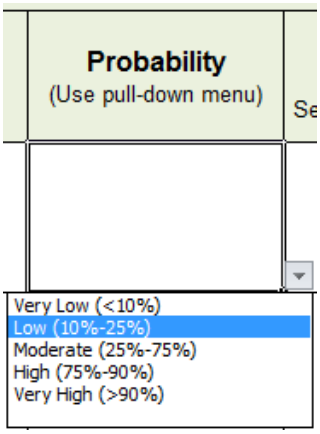
9. Next, fill in the owner and mitigation action fields.

Owner	Mitigation Action
Brian Drendel	Find or build new communicatinos duct path

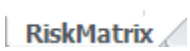
10. We will now determine the Probability, Impact and Severity. All three are selected from pull-down menus. We start with Probability.

Probability (Use pull-down menu)	Impact (Use pull-down menu - See Risk Matrix Worksheet)	Severity (use pull-down menu - See Risk Matrix Worksheet)

11. Select the probability that to most fits the likelihood of this item occurring.



12. We next move on to impact, but this selection is determined via criteria setup in the Risk Matrix. First we navigate to the Risk Matrix



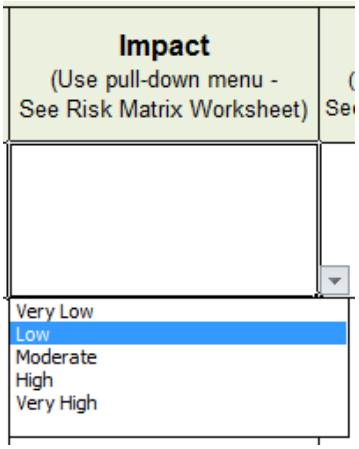
13. Look at the Risk Impact table as shown below. In Step 11.6 we selected a Category. Match this category in the leftmost column of the table with the criteria for that category to determine the impact, which are the colored boxes in the top row.

Use this table to determine the Risk **Impact** in the OpportunitesRisks Workbook

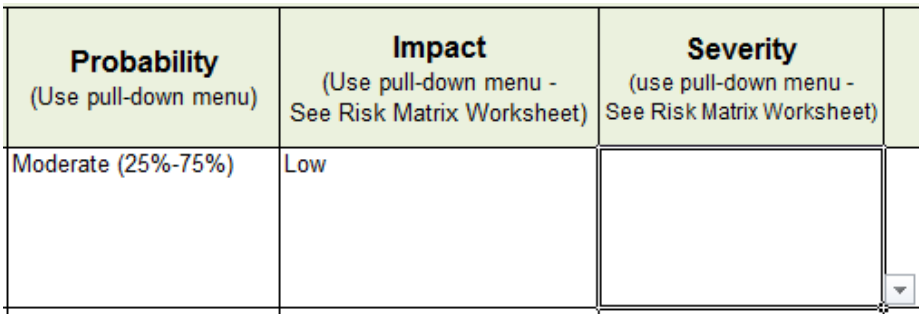
Impact / Risk	Very Low	Low	Moderate	High	Very High
Cost	< $50K	$50K - $100K	$100K - $250K	$250K - $500K	> $500K
ES&H	Negligible	Minimal	Concern	Significant risk	High risk
Schedule	Delays Level 3 milestone or Project critical path by < 1 month	Delays Level 3 milestone or Project critical path by 1 - 3 months	Delays Level 3 milestone or Project critical path by 3 - 6 months	Delays level 3 milestone or Project critical path by 6 – 9 months	Delays Level 3 milestone or Project critical path by > 9 months
Technical	Negligible	Negligible, if any, degradation.	Technical degradation leading to moderately compromised physics objectives.	Technical degradation leading to severely compromised physics objectives.	Technical degradation leading to severely compromised and unrecoverable physics objectives.

14. Navigate back to the Opportunities and Risks worksheet.

15. Select the level of impact determined in the above step.



16. At this point, we have selected the Probability and Impact, but still need to select Severity. Note your selections as they are needed in the next step.



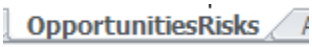
17. To determine the Severity, we must navigate back to the Risk Matrix worksheet.

18. Go to the Risk Severity table. Find the Severity Level (colored boxes) by match the Probability in the first column with the Impact in the top row.

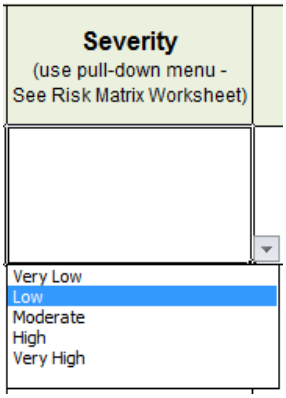
Use this table to determine the Risk **Severity**
(Risk Severity is calcualted from the Risk Impact and Risk Probability in the below table)

	Impact				
Probability	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
Very High (> 90%)	Low	Moderate	High	High	High
High (75% – 90%)	Low	Moderate	Moderate	High	High
Moderate (25% - 75%)	Low	Low	Moderate	High	High
Low (10% - 25%)	Low	Low	Moderate	Moderate	High
Very Low (< 10%)	Low	Low	Low	Low	Moderate

19. Navigate back to the Opportunities and Risks worksheet.



20. Select the Severity Level determined in the previous step.



21. The Probability, Impact and Severity levels have now been determined.

Probability (Use pull-down menu)	**Impact** (Use pull-down menu - See Risk Matrix Worksheet)	**Severity** (use pull-down menu - See Risk Matrix Worksheet)
Moderate (25%-75%)	Low	Low

22. Next fill in any cost and/or schedule impact. The cost is in thousands of dollars, and you only enter the number without any units. The spreadsheet adds the units and "$" sign after you enter the data. Schedule is listed in months.

Cost Impact ($K)	**Schedule Impact** (months)
$100.00K	6

Step 12: Alternatives

The alternatives section allows us to document alternate options that we have considered that are different than the base plan.

1. Navigate to the Alternatives worksheet.

2. Write a description of each alternative plan and reasons why that base plan was chosen instead.

Alternatives:

One alternate solution considered was to pull the new fiber along the existing communicatiuons duct until it intersected the extraction lines enclosure. From there the fiber could be directed along tunnel enclosure cable trays to the MC-1 service buildings. Though this option would provide MC1 cable pull lengths of approximately the same length as the base option, it was eliminated due to the extra complications of both pulling fiber through the tunnel enclosures to Mu2e and AP-30. In both cases, the expected radation environment would require a more expensive radation hardended single-mode fiber. In addition, the CAMAC fiber links only run on multimode fiber, so link and clock repeaters would have to be redesigned to run on single-mode fiber, adding additional expense to the project.

Standard 96 count single-mode fiber costs approximately $1.50/foot, whereas 96 count rad hardended fiber costs approximately $22/foot. Upgrading to the radiation hardened cable would add approximately $50K to the cost of the cable pull. Other fiber optic cable path options have been considered, but prove to be more costly to implement

Step 13: Save BoE file to g-2 Document Database

Save the completed BoE document and any supporting material in the g-2 document database document that was created in Step 2. Normally, there will be one document database document per BoE.